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19. ABSTRACT (Continue on reverse if necessary and identify by block number) This report documents the development and implementation of changes in the organizational structure at SIMA, San Diego, to optimize the system of pump repair. Changes concerned four areas: (1) the Pump Repair Shop (38C), including performance feedback, orientation and training of shop level management and supervisory personnel, and tools and equipment; (2) working relations between 38C and its assist work centers, including integration of electricians into 38C and modification of work acceptance and tracking in the Machine Shop; (3) relations between 38C and SIMA staff support, including planning, technical documentation, and supply procurement; and (4) allocation of physical space for work, storage, and supply support. Redesign of the organizational system for pump repair at SIMA, San Diego, has been successfully accomplished. It remains to complete the training and support system changes in order to institutionalize the improved organizational system and evaluate the long-term effectiveness of the redesigned system.					
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// **NAVY PERSONNEL RESEARCH
AND
DEVELOPMENT CENTER
San Diego, California 92152**



**ENHANCING STRUCTURE AND MANAGEMENT OF NAVY INTERMEDIATE
MAINTENANCE ACTIVITIES: PHASE II. IMPLEMENTATION
OF CHANGES IN THE PUMP REPAIR SYSTEM**

Bela Feher
Mark F. Levine

Reviewed by
E. P. Somer

Released by
John E. Kohler
Commander, U.S. Navy
Commanding Officer

FOREWORD

The concept of work teams was introduced in the Pump Repair Shop at the Navy Shore Intermediate Maintenance Activity (SIMA), San Diego, two years ago to improve productivity. Although the system was successful in increasing output, the Commanding Officer wanted additional evaluation by the Navy Personnel Research and Development Center (NAVPERSRANDCEN) to see whether the work organization could be further improved, to determine how it could be maintained through changes in leadership, and to assess the feasibility of extending the concept to other SIMA shops.

NAVPERSRANDCEN planned the study of the pump repair system in three phases: Phase I focused on analysis of the system and resulted in recommended changes to improve it. This report summarizes how these changes have been implemented in Phase II. A forthcoming byproduct of this phase is a report summarizing the sociotechnical design methodology used in the study. Phase III, as yet unfunded, will comprise a long-term evaluation of the effects of the changes in the system.

Appreciation is expressed by the authors to Captain Hay and to the management and personnel of SIMA for their enthusiastic collaboration in this project. Special appreciation is extended to Mr. Ed Krosky for his support and guidance throughout the project.

J. E. KOHLER
Commander, U.S. Navy
Commanding Officer

JAMES W. TWEEDDALE
Technical Director

SUMMARY

Problem

Efficient maintenance of ships is a vital Navy activity. When the quality of maintenance is uneven and output less than what it should be, the impact can be widespread.

One shop, the Pump Repair Shop at the Navy Shore Intermediate Maintenance Activity (SIMA), San Diego, was experiencing serious performance problems two years ago. Many pumps were being sent back by customers due to inadequate repair and production schedules were not being met. Because of its mission, the shop then and now must operate in an unstable and uncontrollable environment. In addition, it has a high planned personnel turnover rate (60% annually) with most replacements requiring training. The pumps coming in for repair are highly varied in type, size, and condition, making it difficult to standardize the repair process.

At that time a newly assigned Branch Officer reorganized the shop around small work teams which were given total responsibility for the repair of assigned pumps. Over the following year, efficiency increased 50 percent, productivity rose 40 percent, and customers became more satisfied with the quality of the work.

The Commanding Officer, pleased with the change, requested that the Navy Personnel Research and Development Center (NAVPERSRANDCEN) refine the shop organization further and recommend ways to institutionalize it to assure that it would not change as the people were replaced. He also wanted to learn whether the concept would work in other repair shops at SIMA, San Diego.

Phase I of the study was a sociotechnical system analysis of the pump repair process. Researchers found that the work team concept was well suited to the task requirements, operating environment, and personnel training requirements of the shop. Continuing problems in the pump repair process were attributed to a limited perspective in previous changes in which only the core operations in the Pump Shop had been reorganized. Neither ancillary support nor assist work center structure had changed, requiring that pump team members continue to perform tasks that took them away from pump repair. The results of the Phase I study revealed that to maximize effectiveness and long-term viability of the pump repair system, some internal improvements were required in the Pump Shop's organization and operation along with changes in related repair units and in staff functions. Reallocation of space and facilities was also required to accommodate the new system of pump repair. Phase II deals with implementation of the recommended changes.

Objective

The objectives of Phase II were to implement changes recommended in Phase I and assess the usefulness of the sociotechnical system design method for redesigning the work structure of military organizations to improve long-term productivity.

Method

A task force made up of researchers from NAVPERSRANDCEN and members of SIMA management and staff was formed to implement the changes recommended in Phase I of the study. Task force members worked in close collaboration to develop detailed

design recommendations, build consensus, gain command approval, and implement changes.

Results

The task force generated a number of improvements in order to support teams in the Pump Shop.

1. Measurement of team performance was changed to provide a more equitable basis for team competition. Instead of using a simple pump count as the sole basis for measuring team output, values were assigned to individual pumps based on type, size, and condition. This weighting scheme took into account the skill and time required to fix a particular pump. A two-month moving average was also introduced to minimize fluctuations found in monthly output.

2. Researchers are in the process of developing a training program to orient new shop managers and supervisors to the functioning of the teams and the pump repair system.

3. Tools and equipment were upgraded: A compressed air system was installed, custom tool cabinets were designed, and portable tool boxes assembled for shipboard work.

4. Work relations between the Pump Shop and two of its assist work centers were modified to improve efficiency. To overcome coordination difficulties in the repair of motors from close coupled pumps, a number of electricians were transferred to the Pump Shop where they now work as a team responsible for the entire process of overhauling pump motors. Also, all work entering the Machine Shop relating to a particular pump is now scheduled and tracked as a single repair job instead of as several individual jobs. This is done by a single planner designated as point of contact for all machine work for the Pump Shop. He has responsibility for monitoring progress of all components of each pump job through the sections of the Machine Shop and ensuring their completion on schedule.

5. Several changes were made in staff support functions. The planning task was split into advanced planning and concurrent planning. Planning for all emergent work and revisions of job orders after the beginning of the ship's availability period is now performed by Pump Shop planners, minimizing time delays and duplication of effort. In addition, the shop planners are responsible for obtaining all technical documentation and pump parts not anticipated by the advanced planners, thus allowing repair personnel to concentrate on the repair process.

6. A satellite supply store is being established in the building occupied by the Pump Shop. Supply personnel have assumed responsibility for inventory control of the shop's parts and supplies, with the store providing a convenient point of contact between the shop and the Supply Department.

7. Space in the shop building was reallocated to relieve cramped quarters. Two other shops were moved to other buildings, freeing space for work, equipment, and storage for pump teams, electricians, and shop planners, and for the supply store.

All of the changes will be implemented by July 1985 with the exception of the orientation program, which awaits future funding.

Conclusion

The pump repair system at SIMA, San Diego, was successfully redesigned to enhance its operation using the sociotechnical system design approach. This approach was found to have high utility for organization redesign efforts in military activities. Potential benefits to such organizations in terms of increased productivity are significant.

Recommendations

1. The impact of the improved pump repair system should be evaluated after one year.
2. Training for team leaders and orientation for shop-level management should be introduced as soon as possible.
3. Sociotechnical system design should be considered in other repair systems in SIMA that have tasks and operating environments similar to those of the Pump Repair Shop.
4. The sociotechnical system design method should be applied to other IMAs and repair activities to enhance productivity.

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INTRODUCTION

Problem

The Navy Personnel Research and Development Center (NAVPERSRANDCEN) was invited by the Commanding Officer of the Shore Intermediate Maintenance Activity (SIMA), San Diego, to study SIMA's organization, operation, and management in the area of pump repair. The initial impetus for the study came during the prior year when, under the leadership of the Machinery Branch Officer, the Pump Repair Shop (38C) was successfully changed from an organization using a highly specialized division of labor to one based on work teams. This change showed such promise that SIMA management became interested in examining possible refinements to the team design in 38C and the appropriateness of extending it to other SIMA shops.

The focus of the initial phase of the study was analysis of the pump repair process as performed in 38C and its primary assist work centers (AWCs). A product of the Phase I analysis was a series of recommendations for complementary changes in the structure and functioning of AWCs and SIMA staff operations to support the work teams in 38C (Feher and Levine, 1984).¹

Objective

The task of this second phase was to implement organizational changes to enhance the functioning and improve the support of the team-based organization in 38C, with the ultimate goal of institutionalizing an optimal pump repair system. This project was also seen as an opportunity to assess the usefulness of the sociotechnical system design methodology for redesigning the work structure in a military organization to improve productivity. Specifically, the objectives of this phase of the study were threefold: (1) to develop detailed design proposals to support and improve the team-based system of pump repair at SIMA, (2) to facilitate implementation of approved proposals for changes in SIMA's organizational structure and functioning related to the pump repair system, and (3) to assess the utility of the sociotechnical system design method for improving productivity in military organizations.

Background

The pump repair process is a complex system of activities requiring coordinated effort of many production shops and support functions within SIMA. Once a job has been accepted from the Pacific Surface Fleet by the SIMA Type Desk Officer, it has to be planned and scheduled, parts must be procured, and the pump processed via the interrelated efforts of the Pump Repair Shop (acting as lead work center) and its AWCs.

Figure 1 shows the traditional repair process for close coupled pumps which include an electric motor attached as a power source. After arrival at the shop, close coupled pumps used to require the coordinated efforts of the Inside Electrical Shop (51A), the Electroplating Shop (51C), the Sound Vibration Analysis Shop (92A), the Inside Machine Shop (31A), and the Metal Buildup Shop (31M) to support efforts by 38C to return the

¹Feher, B., & Levine M. (September 1984). Enhancing structure and management of Navy intermediate maintenance activities: Phase I. Analysis of the pump repair process (NPRDC Tech. Note 72-84-4). San Diego: Navy Personnel Research and Development Center.

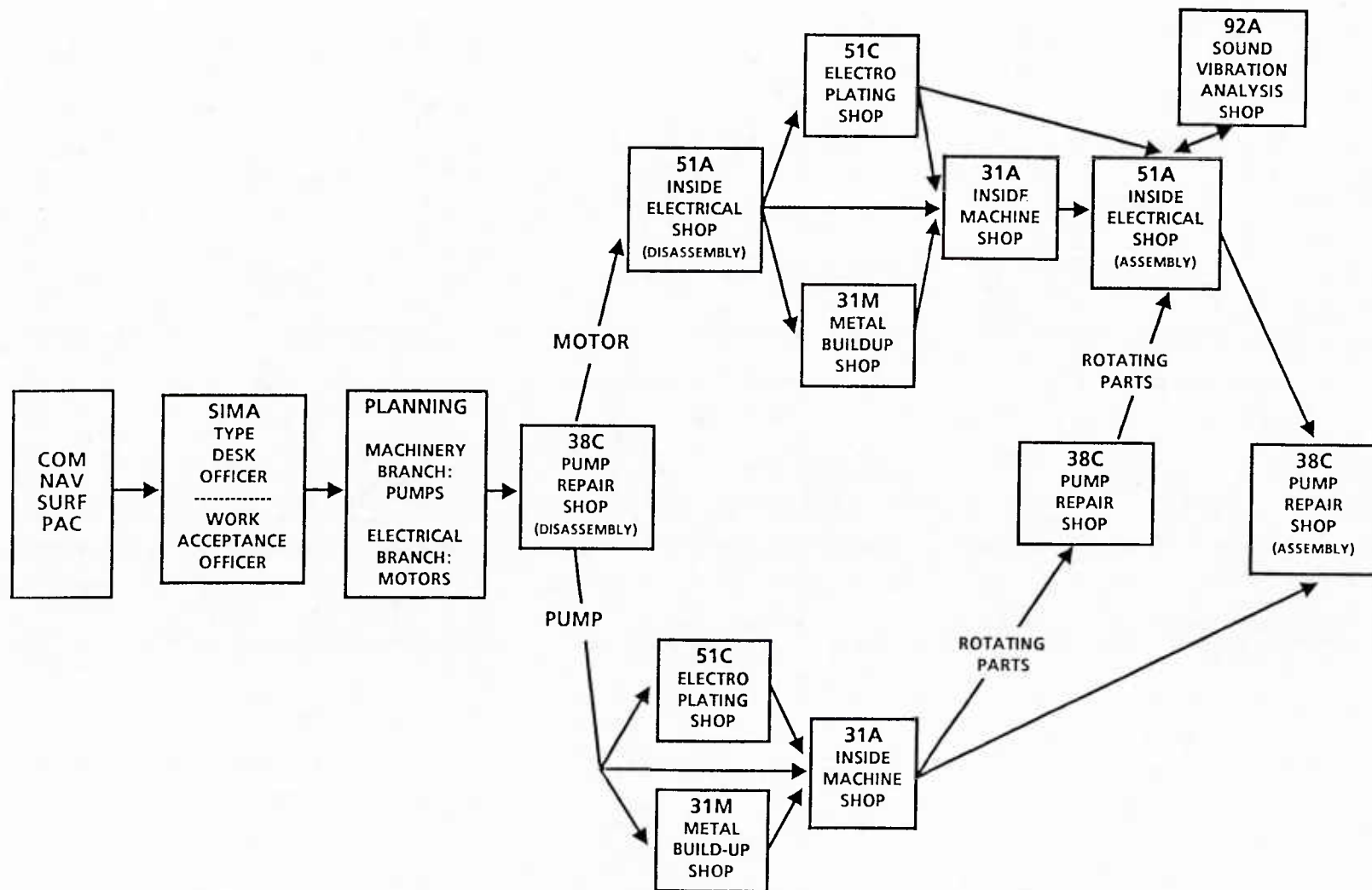


Figure 1. Basic elements of repair process for close coupled pumps.

pump to original design specifications. Even in the less complex case of the coupled pump, which does not include a power source, all of the same shops, with the exception of 51A and 92A, could be involved (Figure 2).

The Phase I analysis determined that work teams were, indeed, well suited to the operating environment, task demands, and personnel training requirements of the Pump Shop. As shown in Table 1, longitudinal analyses of output over a two-year period provided strong support for the concept of work teams within 38C. However, the Phase I analysis found that the overall SIMA organization had not fully adjusted to support these changes.

METHOD

The project was a collaborative effort between the researchers from NAVPERS-RANDCEN and the management and staff of SIMA to diagnose present organizational functioning, identify problem areas, generate alternative solutions, critically evaluate them, recommend preferred solutions, and facilitate implementation of approved changes.

These activities were carried out by a task force whose membership included the authors and a diagonal slice of organization members who had relevant knowledge of pump repair activities and responsibility for them. The following organizational roles were represented:

1. Pump team leaders responsible for coordinating team activities to repair pumps.
2. Shopmaster of the Pump Shop responsible for coordinating all production activities.
3. Machinery Branch Officer responsible for management of the branch which includes the Pump Shop.
4. Repair Officer responsible for overseeing daily repair activities throughout SIMA and interfacing with managers of the ships serviced by SIMA.
5. Production Officer responsible for all production related-activities in SIMA.
6. Executive Officer responsible for production, administration, planning, and scheduling.
7. Civilian Management Engineer responsible for development of standards, design of the management information system and monitoring of all management information.

Members from AWCs assisted the task force when their special expertise was required. Their organizational roles included:

1. Shopmaster of the Electrical Shop responsible for repair of electrical motors associated with pumps.
2. Electrical Branch Officer responsible for management of the branch which includes the Electrical Shop.
3. Shopmaster of the Machine Shop responsible for machine work required to repair components of pumps and motors.

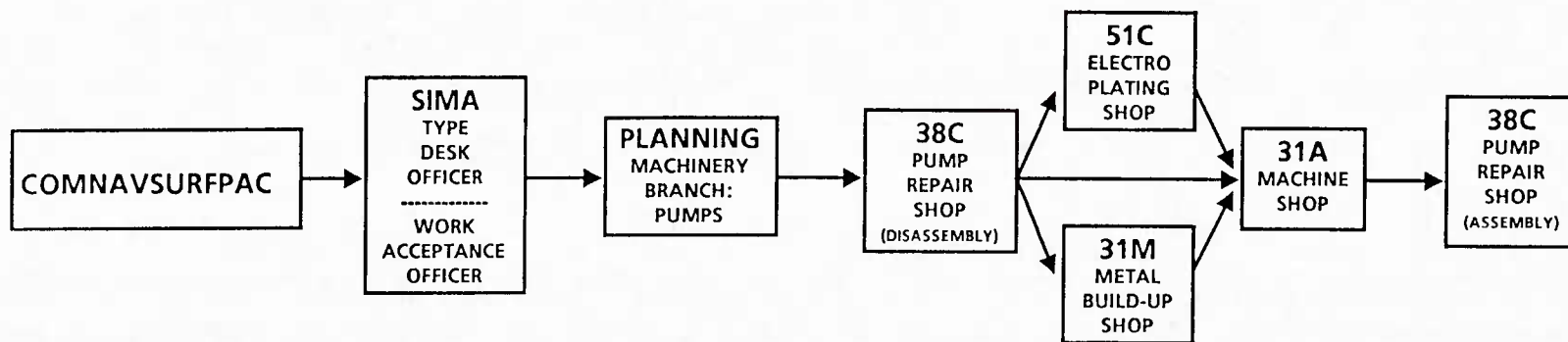


Figure 2. Basic elements of repair process for coupled pumps.

Table 1
Evaluation of Work Team Design in the Pump Shop^a

	Pre-team Concept	Pump Team Concept	Change
Average number of pumps completed per month	35.3	60.3	+71% ^b
Mean production efficiency ^c	72.6%	87.5%	+21%
Mean job efficiency ^d	64.3%	94.6%	+47%

^aComparison is between the period February 1982 through January 1983 (pre-team concept) and the period June 1983 through June 1984 (pump-team concept). This reflects a 4-month transition period (1 February - 31 May 1984) and one month for which data are missing.

^bForty percent when adjusted for manning level.

^cAverage monthly production efficiency calculated at a ratio of documented man-hours expended on completed jobs during the month divided by available production man-hours in the shop for the period.

^dAverage monthly job efficiency calculated at a ratio of estimated man-hours (from SIMA Standards Manual) for pumps completed plus documented man-hours on cancelled jobs, divided by available production man-hours in the shop for the period.

Other task force members were associated with various staff support functions in SIMA. These included the following:

1. Three persons from the Planning Department: the Planning Officer, civilian Head of Planning, and civilian Supervisor of Planning related to pumps, all of whom were responsible for processing work requests and forwarding them to 38C.

2. Civilian Design Engineer responsible for technical drawings and manuals required for pump repair.

3. Supply Officer responsible for procuring parts and materials required for repairs.

Structured and unstructured interviews, observation, and analysis of historical records were used during Phase I to gain an understanding of the pump repair process. Based on the findings of the initial phase, discussions among task force participants were used to develop solutions and build consensus prior to submitting recommendations for formal approval by the SIMA Commanding Officer.

RESULTS

Changes undertaken in Phase II concerned four areas: (1) 38C itself; (2) the relationship between 38C and its AWCs; (3) the relationship between 38C and SIMA staff support; and (4) the allocation of physical space.

Changes Within 38C

Within the Pump Shop changes were made in three areas: (1) measurement and feedback of team performance, (2) supervisory training and management orientation, and (3) tools and equipment.

Change 1: Measurement and Feedback of Team Performance

Previously, team output was measured as the number of pumps completed per month. Each team's total for the period was publicly posted and served as the basis for competition among the teams for recognition as the "best."

It was widely understood among team members that the simple output count was inequitable because some pumps required more skill and time to repair than others. To address this problem, the pump team leaders and the shop documenter were asked by the authors to develop a weighting scheme reflecting the differences in pump type, size, and condition upon arrival for repair. They developed a pump point system by which the documenter can assign from one to five points for size and one to five points for condition for each type of pump. This resulted in each pump having an assigned value of from two to ten points prior to arrival at the shop. The documenter adds up the point values for the completed pumps to arrive at a monthly total for each team. These scores are fed back to the teams on a monthly basis along with the pump count.

Two major reactions emerged among team members during a trial of the pump point system. First, they felt the point system added valuable information regarding what had been accomplished. Second, they registered greater interest in working on larger or more difficult pumps because the point system gave them "credit" for the greater effort and skill required.

Examination of the data in Table 2 for the two-month trial of the pump point system reveals that monthly pump points discriminate clearly between teams producing at the same level in terms of pump count alone. The rank ordering of teams under the two systems often deviates but never by more than one position. However, there may be extreme fluctuations in the rank ordering of teams from month to month because most of the work on a pump may be performed in the month prior to the one in which the job is completed. (Note in Table 2 the scores for teams 5 and 6 from September to October.) To minimize this effect in the point total, the documenter computes a moving average of two months.

Change 2: Training and Orientation Program

The operation of the teams and the shop and their relationships with the larger SIMA organization are complex and unfamiliar to incoming personnel. Incoming shop-level management personnel and team leaders in 38C need functional training to perform effectively within this new pump repair system. To accomplish this an outline of a training and orientation program was developed as the basis for a script and proposed video tape (see Appendix). Repair operations may be filmed on-site as well as interviews with personnel who play key roles in the pump repair process.

The proposed program covers the following topics:

History of the team-based organization in 38C.

Table 2

Pump Repair Team Performance Measured by Weighted and Unweighted Production Count

Team	Performance											
	September				October				September/October Average			
	No. pumps	Team rank	Pump points	Team rank	No. pumps	Team rank	Pump points	Team rank	No. pumps	Team rank	Pump points	Team rank
1	12	5	55	5	4	6	14	6	8.0	6	34.5	7
2	13	3	63	3	6	4	28	4	9.5	2	45.5	3
3	13	3	61	4	6	4	22	5	9.5	2	42.5	6
4	16	1	77	2	7	3	31	3	11.5	1	54.0	1
5	6	7	32	7	12	1	54	1	9.0	4	43.0	5
6	15	2	89	1	2	7	8	7	8.5	5	48.5	2
7	8	6	47	6	8	2	40	2	8.0	6	43.5	4

Overview of the pump repair process, including

- SIMA support
- Initial Pump Shop activities
- AWC activities
- Reassembly and testing by pump team
- Delivery and reinstallation of pump.

Pump team structure and dynamics, including

- Team size and composition
- Work assignment
- Leadership and supervision
- Training
- Recordkeeping
- Performance feedback.

Key roles within the Pump Shop.

Change 3: Tools and Equipment

The Phase I analysis revealed that the inventory control system for tools in 38C, relying as it did on individual tool checkout from a central tool crib, was time-consuming and ineffective in preventing tool loss. Omission of one or more required tools for shipboard work due to the piece-meal checkout system could also result in gross inefficiencies. Furthermore, it was obvious that ease and speed of disassembly and assembly could be improved considerably by use of pneumatic tools.

The first step in upgrading tools and equipment was to install a compressed air system throughout 38C. Next, custom tool cabinets were supplied on a trial basis to two teams. Each cabinet was equipped with a standard set of hand and pneumatic tools arranged in such a manner that inventory took only a glance. Additional cabinets will be acquired as budget allows. Portable tool kits designed for shipboard tasks are also being evaluated.

The new equipment should improve the efficiency of the disassembly/reassembly process while meeting the need for inventory control.

Changes in Relationship of 38C and its Primary AWCs

The relationship between 38C and the Inside Electrical Shop (51A) and between 38C and the Inside Machine Shop (31A) were identified as crucial for improving efficiency and effectiveness of the pump repair system.

Change 4: Relationship between 38C and 51A

Close coupled pumps, which represent 60 percent of 38C's workload, initially required 51A to act as an AWC for the repair of the electrical motor. The Electrical Shop used a highly fractionated division of labor which had a negative impact on the pump repair system. Problems included lack of coordination within 51A and between 38C and 51A, non-productive use of time, production delays, and difficulty in meeting deadlines. Motivational problems stemmed from lack of worker identification with the ultimate product, a pump, and resultant lack of pride of ownership. Communication between 51A

and 31A regarding deadlines, priorities, and work specifications was compromised. Interpersonal relations and intershop communication between 38C and 51A had deteriorated. Further, the existing work system design prevented personnel in 51A from gaining hands-on experience in the complete repair process for electrical motors.

To overcome these problems, 14 electricians were transferred from the Electrical Branch to the Machinery Branch to work with 38C teams. The electricians now work as a team and have responsibility for the entire process of overhauling pump motors. Electrical Branch assistance is now only required for electroplating, occasional rewinding, and balancing, each of which requires specialized skills and equipment.

This change improved Machinery Branch control over the activities required to repair close coupled pumps and eliminated most interbranch problems. It also improved the skill level of electricians by providing experience in overhauling a full range of close coupled pump motors.

Change 5: Relationship between 38C and 31A

The pumps overhauled by 38C require a wide range of machining--some pumps need only the turning of a wearing ring while others require a new shaft. Machining services are provided to the entire SIMA organization by 31A, with 50 percent of its workload originating in 38C. Internal scheduling of work in 31A was initially performed individually for each part according to the shop workload at the time of arrival, as opposed to treating all parts of a particular pump as a unit. This caused problems in coordination between 38C and 31A, in tracking work in progress, and in accountability for timely delivery of all parts associated with each pump.

To overcome these problems, the process of work acceptance in 31A was revised to schedule and track work by product and job. Incoming work was divided between the 31A planners according to shop origin, with one planner serving 38C (pumps and motors), the Outside Machine Shop, and the Electrical Branch, and the other serving the Valve Shop, the Hull Branch, 31A, and performing miscellaneous work. To speed up material ordering and scheduling in 31A, team leaders in 38C became responsible for informing 31A planners of all machining assistance required as soon as a pump was opened up. When the pump parts are delivered to 31A, the 31A planner issues them to the floor and monitors their progress through the lathe, grinding, and milling sections, so that all components for a single job are completed on time.

Changes in Relationship of 38C and SIMA Staff Support

The process of pump repair requires a wide range of support from SIMA, including planning, scheduling, technical documentation, procurement of materials and supplies, management information and liaison with the fleet. Although all of these functions could conceivably be modified to improve pump repair effectiveness and efficiency, the focus of the Phase I analysis and the Phase II changes was limited to three areas which were identified as critical: (1) planning, (2) technical documentation, and (3) supplies.

Change 6: Planning

Initially, all planning was centralized. Approximately 45 days prior to the beginning of the ship's availability period with SIMA, planners prepared a job order based on the

automated work request submitted by the ship. They verified the identification of the pump (by physical inspection, if possible), gathered technical documentation (prints and manuals), ordered parts, set a completion date, and forwarded the work package to the lead work center with copies of the job order to all AWCs. When revisions were required, based on shipboard inspection or pump disassembly, paperwork flowed back to the Planning Department for processing before returning to the shop to activate work. This caused a three- to four-day delay, which was often critical in meeting a ship's required completion date. Delays also occurred with emergent work (i.e., newly submitted jobs not planned prior to arrival of the ship) due to processing by central planning. In addition, for a variety of reasons there was considerable duplication of effort by planners and 38C production personnel in the performance of ship checks, retrieval of technical documentation, and ordering of parts, resulting in a loss of production time.

To overcome these problems, a portion of planning was decentralized. A new position, shop planner, was created in 38C. Four persons, two from central planning and two from 38C, were given cross-training in the planning and pump repair processes to perform in this role. They were given responsibility and authority to carry out planning functions for revisions and emergent work required after the beginning of the ship's availability period. Shop planners decide jointly with team leaders how to handle work that requires revisions.

This decentralization of planning eliminated time delays and duplication of effort, while giving shop planners on-site exposure to the complex process of pump repair. At the same time, the pump repair teams gained direct, convenient access to knowledgeable planners.

Change 7: Technical Documentation

Technical documentation is necessary for the repair process. Although the responsibility for obtaining documentation from the Technical Library was formerly assigned to the central planners, it was often necessary for repair personnel to invest time in seeking other manuals or prints to meet their special needs. To eliminate this problem the shop planner was made responsible for procuring all supplemental technical documentation. The shop planners work with the librarians to identify and locate required documentation, which is then loaned to the shop.

It is intended that shop planners will establish on the shop floor a small working library of technical manuals and blueprints for the more frequently repaired pumps. Documentation retained permanently by the shop will be replaced by the Technical Library.

Change 8: Supplies

Generally, 38C is required to work within a tight schedule dictated by the fleet. The parts and materials necessary for pump repair are procured through a centralized supply operation in SIMA which has interface with the Navy supply system and functions according to federal and Department of Defense procurement regulations. To facilitate timely parts procurement, 38C has traditionally used production personnel to handle paperwork, track orders, pick up deliveries, and act as supply petty officers for small inventories of "pre-expended bin" (PEB) items (high demand items of moderate value issued to the shop in advance of a particular job requirement) and leftover items from previous jobs. This diversion of production time became a considerable burden on the pump repair teams, shop, and branch.

To relieve the shop of this burden of non-productive use of personnel, the concept of a satellite supply store was developed. This store is to be established in the building occupied by 38C, the Electrical Branch, and Valve Shop. The store is to serve all shops in the building, assuming responsibility for inventory control for Electrical and Machinery Branch PEB items and carrying, for as broad a range as practical, backup stock of low cost, high volume parts and materials. Present unauthorized stockpiles of parts are to be absorbed into the store or main supply or sent off for disposal.

Through improved inventory control, the store and the shop PEB programs should expand the assortment of items available while ensuring adequate depth of stock to prevent running out. The shops (especially Electrical) should experience a reduction in personnel and space required for parts handling due to elimination of stockpiles. In addition, the store will provide a local point of contact between shop personnel and the Supply Department.

Development of the satellite supply store is to be accomplished in two stages. During the initial stage the Supply Department will assume responsibility for inventory control of PEB items in Building 3278 (the building occupied by 38C), set-up the physical facility for the store, and begin its operation. This includes determination of parts and materials which could advantageously be stocked in the store, transferring and cataloging parts from unauthorized shop stockpiles, obtaining storage equipment, and determining manning requirements. During the second stage it will process requisitions in the satellite store, thus speeding up response time for obtaining parts and materials. This is dependent on Navy-wide adoption of SUADPS-RT, an automated supply processing system which is expected to be on-line by FY86. However, expediting orders must continue to be centralized due to dependence on various electronic assists and data bases.

Personnel to operate the store will be drawn from two sources: (1) present Electrical, Valve, and Pump Shop personnel who are performing similar functions and (2) Supply Department personnel. It is anticipated that elimination of duplication of functions among shops and a more professional operation will result in greater overall efficiency in personnel utilization.

Changes in Physical Space

A number of conditions required improvement of the physical layout for pump repair. They included the following:

1. Insufficient work space for pump repair teams due to a 70 percent increase in pump repairs over the previous 18 months.
2. Insufficient space for electricians involved in pump motor repair who needed to be located near pump repair teams.
3. Insufficient space to locate shop planners (along with their equipment) near pump repair teams and electricians.
4. Insufficient storage space for work in progress due to increased pump production and the presence of motors from close coupled pumps.
5. Insufficient space for new equipment (e.g., a larger sandblaster) for both pumps and motors.

6. Space was required for the satellite supply store.

These conditions required vacating some space in the existing building by moving out shops and reallocating space within the building.

Change 9: Vacating Space in Building 3278

Two of the Machinery Branch shops occupying Building 3278 were identified as desirable candidates for relocation: the Auxiliary Shop (38D) and the Hydraulic Shop (31F). Space on the first deck occupied by 38D was highly desirable because it was adjacent to the Pump Repair Shop and conveniently close to large equipment in the Electrical Branch necessary for motor overhaul. A relatively large, under-utilized space on the second deck, occupied by 31F, was earmarked for the satellite supply store. Relocation of 38D and 31F was possible on completion of a new building (3339) near Building 3278.

Change 10: Reallocation of Space in Building 3278

Figure 3 shows the reallocation of space in Building 3278 vacated by 38D. Pump Shop electricians and shop planners were given work and equipment space. The small sandblaster was removed, expanding the pump repair work space, and a larger sandblaster installed in a central location. The Air Compressor Shop was given a small area due to its displacement from other quarters. An expanded storage area for pumps and motors was identified and vertical storage equipment ordered. The space in the Electrical Branch receiving area vacated by the 38C electricians was returned to the branch pending decision about its importance to the satellite supply store for accommodating weight constraints on the second deck.

The reallocation of space on the second deck of Building 3278 is shown in Figure 4. The area vacated by 31F was given to the Supply Department to be developed into the satellite supply store. The present 51A supply space will be returned to production use once the satellite supply store is operational.

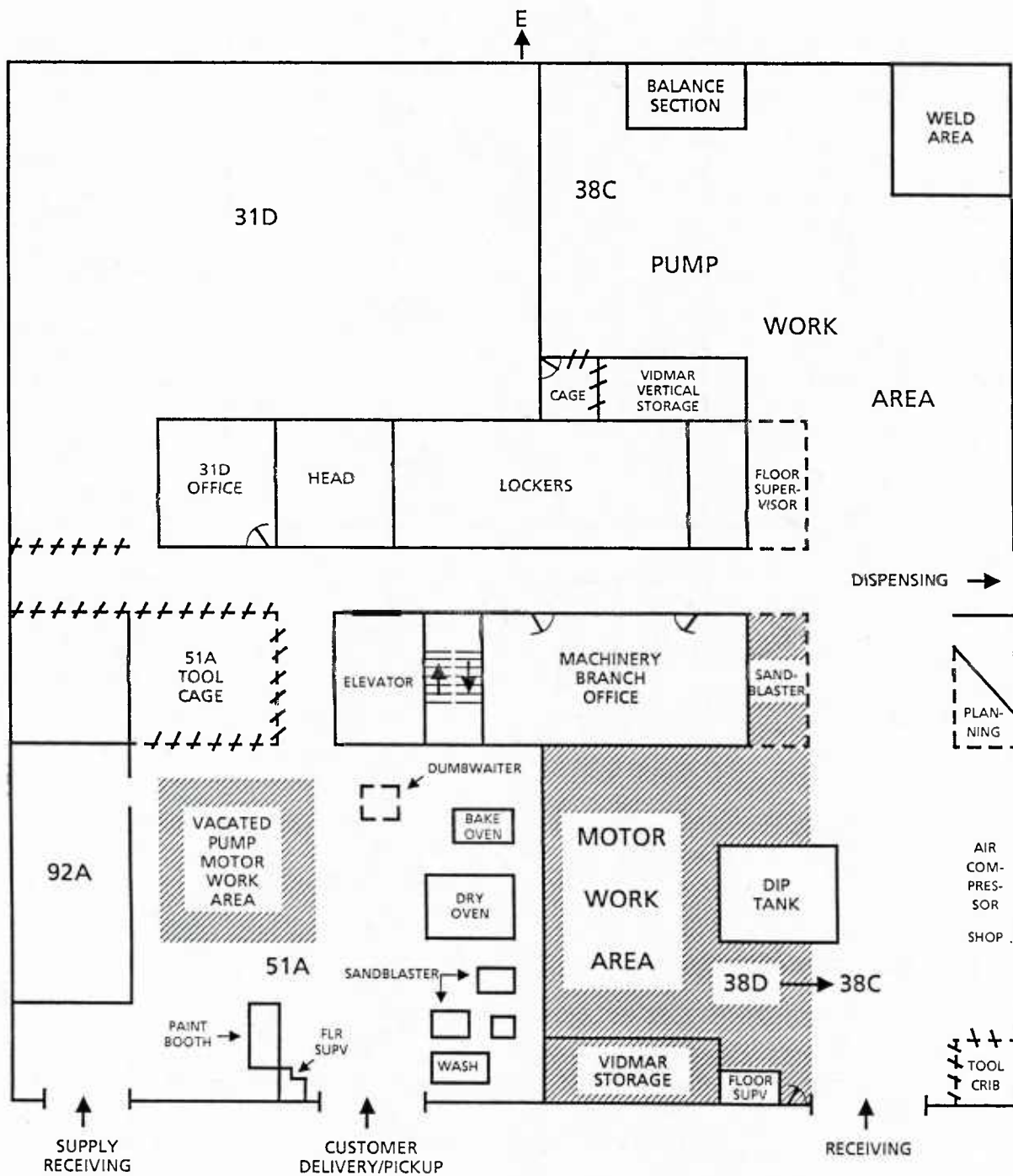


Figure 3. Reallocation of space on the first deck of Building 3278.

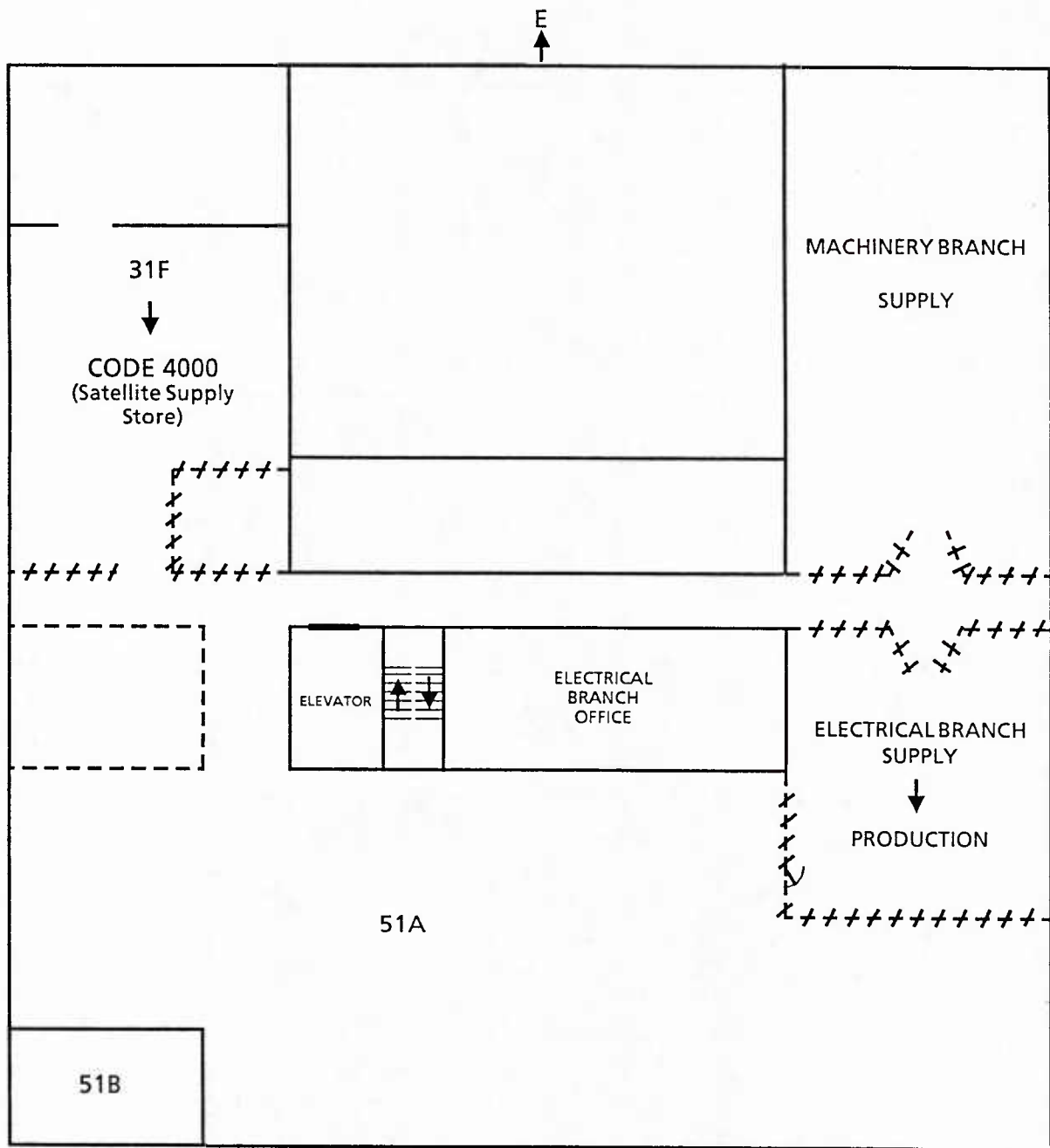


Figure 4. Reallocation of space on the second deck of Building 3278.

SUMMARY AND TIMETABLE OF CHANGES

The change to a team-based organization in 38C improved productivity of the shop. Some recommended changes supporting this major reorganization have likewise been completed, while others are still in progress. A summary of changes and a timetable for accomplishment follow.

	<u>Accomplishment Date</u>
<u>Changes Within 38C</u>	
1. Addition of team performance measurement system which weights pumps according to type, size, and condition.	9/84
Feedback of 2-month moving average to minimize fluctuations.	7/85
2. Training and orientation program for incoming shop-level management and supervisory personnel designed and produced.	1/85 10/85
3. Installation of compressed air system;	9/84
standardized tool cabinets and portable tool boxes supplied to first two teams;	1/85
cabinets and tool boxes supplied to two additional teams per quarter.	4/85, 7/85, 10/85
<u>Changes in Relationship of 38C and its Primary AWCs</u>	
4. Fourteen electricians moved from 51A to 38C to repair close coupled pump motors.	7/84
5. Role of 31A shop planners redefined to comprise scheduling and tracking of work by product, with each planner serving a subset of shops.	12/84
<u>Changes in Relationship of 38C and SIMA Staff Support</u>	
6. Shop planner position created in 38C for processing revisions and emergent work after the ship's availability period begins.	10/84
7. 38C shop planners given responsibility for obtaining technical documentation and building a shop library of frequently needed manuals and prints.	10/84
8. Satellite supply store developed in Building 3278 to manage inventory for 51A, 31D, and 38C PEB programs;	2/85
to provide a point of contact with supply,	2/85
and store high volume parts and materials for 51A, 31D, and 38C.	6/85

Changes in Physical Space

- | | |
|---|-------|
| 9. Relocation of 38D and 31F to Building 3339. | 12/84 |
| 10. Reallocation of space on the first deck in Building 3278 to 38C repair teams, electricians, shop planners, Air Compressor Shop and for new equipment and storage; | 12/84 |
| reallocation of space on the second deck to supply, | 12/84 |
| and electrical branch production. | 6/85 |

DISCUSSION

A number of critical changes remain to be accomplished. The Supply Department assumed inventory management of the PEB program in Building 3278 in February 1985. Completion of a study and approval of a plan for the satellite store occurred in January, with July set as the target date for it to become operational. Tools and cabinets for the first two teams were delivered in mid-January. Additional cabinets to equip the remaining teams will be acquired two at a time in subsequent fiscal quarters following the initial trial period. Feedback of team performance using a moving average will begin when the workload reaches shop capacity again (about July). Finally, production of video cassettes for training purposes is targeted for October, pending funding.

CONCLUSIONS

The sociotechnical system design method was successfully used to develop and implement changes in the structure and functioning of the Pump Repair Shop, in redefining its relationships with its primary AWCs and with the SIMA support staff, and in allocation of physical space to support the team-based work system design.² It remains to complete the training and support system changes to institutionalize the improved organizational system, followed by long-term evaluation.

RECOMMENDATIONS

1. The improved pump repair system should be evaluated after one year.
2. Training for team leaders and orientation for shop-level management should be introduced as soon as possible.
3. Sociotechnical system design should be considered in other repair systems in SIMA that have tasks and operating environments similar to those of the Pump Shop.
4. The sociotechnical system design method should be applied to other IMAs and repair activities to enhance productivity.

²Readers interested in a detailed discussion on the theory, principles and method of sociotechnical system design are referred to Feher, B. & Levine, M. (July 1985). Organization redesign for productivity improvement: Method and case study (NPRDC Tech. Rep. in press). San Diego: Navy Personnel Research and Development Center.

APPENDIX

ORIENTATION AND TRAINING PROGRAM FOR 38C: PROPOSED OUTLINE FOR VIDEO CASSETTE

ORIENTATION AND TRAINING PROGRAM FOR 38C: PROPOSED OUTLINE FOR VIDEO CASSETTE

I. History.

A. Structure and functioning of 38C prior to the "team concept" (chart).

1. Two 15-20 person teams with specialized skills: (a) disassembly (sometimes including removal, (b) reassembly (sometimes including reinstallation).
2. Assignment of current work to personnel on the basis of availability at the moment; hence, little identification with the product or accountability for work performed.

B. Reasons for change.

1. High rework and customer dissatisfaction over quality of repairs.
2. Inadequate quantity.
3. Poor schedule adherence.

C. Present structure and functioning of 38C (chart).

1. Multiple teams, each with responsibility for entire repair job on pumps assigned, including their removal and replacement.
2. Shop, Branch and SIMA resources organized to support pump teams.

D. Data on success of new design.

1. Pumps completed.
2. Production/job efficiency.
3. Other (management judgments): quality/rework; identification/responsibility/accountability; customer satisfaction; top management satisfaction.

E. Summary: 38C's team-based design has been effective in meeting the demand for repair of pumps. It is important that every member of 38C understand how it functions, what its goals are, and how each new member is critical to its continuing success. Though successful, 38C cannot operate by itself; hence, it is important to understand its relationships with the rest of SIMA.

II. Overview of the Pump Repair Process.

A. SIMA support.

1. Work acceptance (SURFAC Maintenance Control Center-->SIMA Work Acceptance Officer-->Type Desk Officer).

2. Advanced planning permits:

- a. Job order to be forwarded to Shop.
- b. Material request list to be forwarded to Supply Department.
- c. Technical documentation to be forwarded to Shop.
- d. Scheduling of repair (beginning and completion dates).
- e. Pre-availability conference: Ship superintendent and ship's force.

B. Initial Pump Shop Activities.

- 1. Assignment of pump to a team.
- 2. Shipcheck by shop planner and pump team leader.
 - a. Revision of job order for incorrect identification or for foundation, piping, or access work.
 - b. Scheduling for rigging, craning, and transportation.
- 3. Removal and delivery of pump to Shop.
- 4. Opening of pump--assessment of job.
 - a. Team interface with shop planners.
 - (1) Supplementary parts order.
 - (2) Additional technical documentation.
 - (3) Revision of job order to include additional AWCs.
 - b. 38C team interface with 31A planner.
 - c. Delivery of motor from close coupled pumps to electricians who assess and repair motor:
 - (1) Surge testing
 - (2) Disassembly and cleaning
 - (3) Measurement
 - (4) Parts procurement
 - (5) Machining
 - (6) Plating
 - (7) Reassembly
 - (8) Sound/vibration analysis.

C. AWC activities.

- 1. Delivery by pump team, specification of work required, and scheduling of completion date.
- 2. Work performed while tracking against completion date.
- 3. Examples: 31A, electroplating, metal buildup, sound and vibration analysis, welding, rewind.

- D. Reassembly and testing by pump team.
 - 1. Gathering of required parts and components from Supply and AWCs.
 - 2. Reassembly of pump.
 - 3. Quality assurance inspection.
 - 4. Pressure testing.
 - E. Delivery and reinstallation of pump.
 - 1. Scheduling of ship access, transportation, craning, and rigging.
 - 2. Mounting and hook-up.
 - 3. Operational test.
- III. Pump team structure and dynamics.
- A. Team size and composition.
 - B. Work assignment.
 - 1. Key concept: Develop multiple, comprehensive skills in each team member and depth within each team and among teams for task accomplishment.
 - 2. Goal: Feeling of identification with each successfully completed pump; feeling of responsibility for workmanship; accountability within climate of concern for system performance (quality and quantity).
 - C. Leadership and supervision.
 - 1. Coordination, liaison, and planning.
 - 2. Technical (repair knowledge and skills).
 - 3. Production oversight.
 - D. Training.
 - 1. On-the-job training/apprenticeship.
 - 2. In-house, e.g., by equipment maintenance engineer.
 - 3. SQIP (Shop Qualification Improvement Program).
 - 4. Schools.

E. Recordkeeping.

1. By team--log of progress on each job; tracking completion dates for parts from AWCs.
2. By shop planners--parts ordered.
3. By shop management--hot (high priority) jobs.

F. Performance feedback.

1. Number of completed pumps.
2. Weighted production counts (pump points).

IV. Key roles within the Pump Repair Shop.

- A. Team leaders: provide technical supervision, coordination with AWCs, and schedule team activity.
- B. Troubleshooters: provide on-call technical expertise to pump teams.
- C. Shop planners: provide planning (including shipchecks), technical documentation, and procurement support to pump repair teams.
- D. Documenter: checks accuracy and completeness of job orders; assigns jobs to teams; submits record of man-hours on each job to ADP (including overtime); provides performance feedback to teams.
- E. Shopmaster: provides technical supervision and administrative support; serves as an interface with Machinery Branch management and SIMA.
- F. Division Officer: provide administrative and management support.
- G. Branch Officer: serves as an interface with SIMA line and staff.

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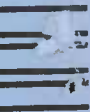
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